

## DISPERSION, HABITAT USE, HUNTING BEHAVIOR, VOCALIZATIONS, AND CONSERVATION STATUS OF THE NEW GUINEA HARPY EAGLE (*HARPYOPSIS NOVAEGUINEAE*)

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**ABSTRACT.**—We studied the dispersion, habitat use, hunting behavior, vocalizations, and conservation status of the New Guinea Harpy Eagle (*Harpyopsis novaeguineae*) from December 1998–October 1999 in Crater Mountain Wildlife Management Area (CMWMA), Eastern Highlands Province, Papua New Guinea. Based on territory mapping, we estimated that the mean home range size was  $13.0 \pm 3.9 \text{ km}^2$  ( $\pm \text{SD}$ ,  $N = 5$ ). One pair we followed for 42 d over a 4 mo period used an area of only  $0.25 \text{ km}^2$ . We followed the male hunting in this area for 6 d (510 min). A small sample of prey items included ground-dwelling species such as forest wallaby (*Dorcopsulus* sp.), juvenile Dwarf Cassowary (*Casuarius bennetti*), New Guinea Megapode (*Megapodius decollatus*), and an arboreal marsupial. Eagles called mainly during daylight hours, mostly near sunup. Spectrogram analysis indicated there were two main calls. A continuous, low frequency, far-carrying call that was used to advertise territories and for contact between mates over distances  $<2 \text{ km}$  and a higher frequency, chicken-like call that was used in interactions between individuals that were close to each other and during hunting, perhaps as a stimulus or lure for prey. In contrast to the rest of the Highlands, eagles were protected inside CMWMA under agreements between villagers and international conservation organizations.

**KEY WORDS:** *New Guinea Harpy Eagle, Harpyopsis novaeguineae, Papua New Guinea, rainforest, vocalizations.*

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Dispersión, uso de habitat comportamiento de caza, vocalizaciones y estado de conservación del águila Harpia de Nueva Guinea (*Harpyopsis novaeguineae*)

**RESÚMEN.**—Estudiamos la dispersión, uso de hábitat, comportamiento de caza, vocalizaciones y estado de conservación del águila harpía de Nueva Guinea (*Harpyopsis novaeguineae*) desde Diciembre de 1998—Octubre de 1999 en Área de Manejo de Vida Silvestre de Crater Mountain (AMVSCM) Provincia de Eastern Highlands, Papua Nueva Guinea. Con base en un mapa del territorio, estimamos el tamaño promedio del rango del hogar:  $13.0 \pm 3.9 \text{ km}^2$  ( $\pm \text{SD}$ ,  $N = 5$ ). Una pareja seguida por 42 días en un periodo de 4 meses utilizo un área de  $0.25 \text{ km}^2$ , seguimos al macho cazando en esta área por 6 días (510 minutos). Una muestra pequeña de ítems incluyo especies del sotobosque como wallaby de bosque (*Dorcopsulus* spp.), casuarius enanos juveniles (*Casuarius bennetti*), megapodos de Nueva Guinea (*Megapodius decollatus*), y un marsupial arboreo. Las águilas vocalizaron principalmente durante el día, hacia el amanecer. Los análisis del espectrograma indicaron que hubo dos vocalizaciones principales. Una continua, con baja frecuencia, que se podía escuchar lejos utilizada para marcar el territorio y contactar las parejas a distancias de  $<2 \text{ km}$  y una con una frecuencia alta, parecida a la de una gallina que fue utilizada en interacciones entre individuos que estaban cerca el uno del otro durante la caza, quizás utilizada como estímulo o como señuelo para las presas. En contraste al resto de las Highlands, las águilas estaban protegidas dentro de AMVSCM bajo acuerdos entre los pobladores y organizaciones internacionales de conservación.

[Traducción de César Márquez]

The New Guinea Harpy Eagle (*Harpyopsis novaeguineae*) is a poorly-known, forest eagle endemic to

Papua New Guinea and Irian Jaya. It is widespread but uncommon throughout undisturbed forests but only two short notes have been published on its ecology, one on its vocalizations (Shulz 1987), and one on its hunting behavior (Beehler et al.

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1992). Little is known about range-restricted raptors in tropical forests, yet they are among the most threatened species and habitats in the world (Bildstein et al. 1998). The need for more information on New Guinea Harpy Eagle led us to undertake this study.

#### STUDY AREA AND METHODS

We studied New Guinea Harpy Eagles from December 1998–October 1999 in Papua New Guinea. The main study area was in Crater Mountain Wildlife Management Area (CMWMA), which extends for approximately 2700 km<sup>2</sup> on the south side of the New Guinea Cordillera, in Chimbu and Eastern Highlands Provinces (06°40'S, 145°00'E). CMWMA is approximately 85% undisturbed montane forest and 15% villages and cultivation. Of the forested area, 60% is used for hunting of bushmeat. During our study, there was no seasonal pattern of rainfall. The area has been the subject of combined conservation and sustainable development initiatives since 1994 (Johnson 1997). Fieldwork was carried out in forest owned by Gimi villagers at elevations between 200–3000 m. Additional field trips were made to the upper Jimi Valley (05°34'S, 144°39'E) and the northeast edge of the Kubor Range (05°53'S, 144°22'E) in Western Highlands Province and Mount Giluwe (06°02'S, 144°00'E) in Southern Highlands Province. There, we interviewed people from Imbongu, Melpa, and Jiwaka groups who had different customs and attitudes toward the eagle than the Gimi. This allowed us to assess the impact of hunting on eagle numbers across regions.

We searched for eagles in all suitable habitats. Eagles were usually located by their distinctive, far-carrying calls and were then observed and followed for as long as possible. Locations of eagles were derived using compass bearings from known points established with a GPS unit and an estimate of the distance to eagle perches. When one eagle was followed or seen several times on the same day, this was counted as one sighting. These data were then plotted with basic topographical information using ArcView 3.0 (ESRI Inc. 1994).

Recordings of vocalizations were made using a Sony TC-D5 Pro II and Sennheiser ME 66 microphone. Spectrograms were made to illustrate each type of call using Canary 1.5.1 software (Cornell Laboratory of Ornithology 1997). All spectrograms used a sampling rate of 12 kHz on a Hanning window of 256 pts with 75% overlap.

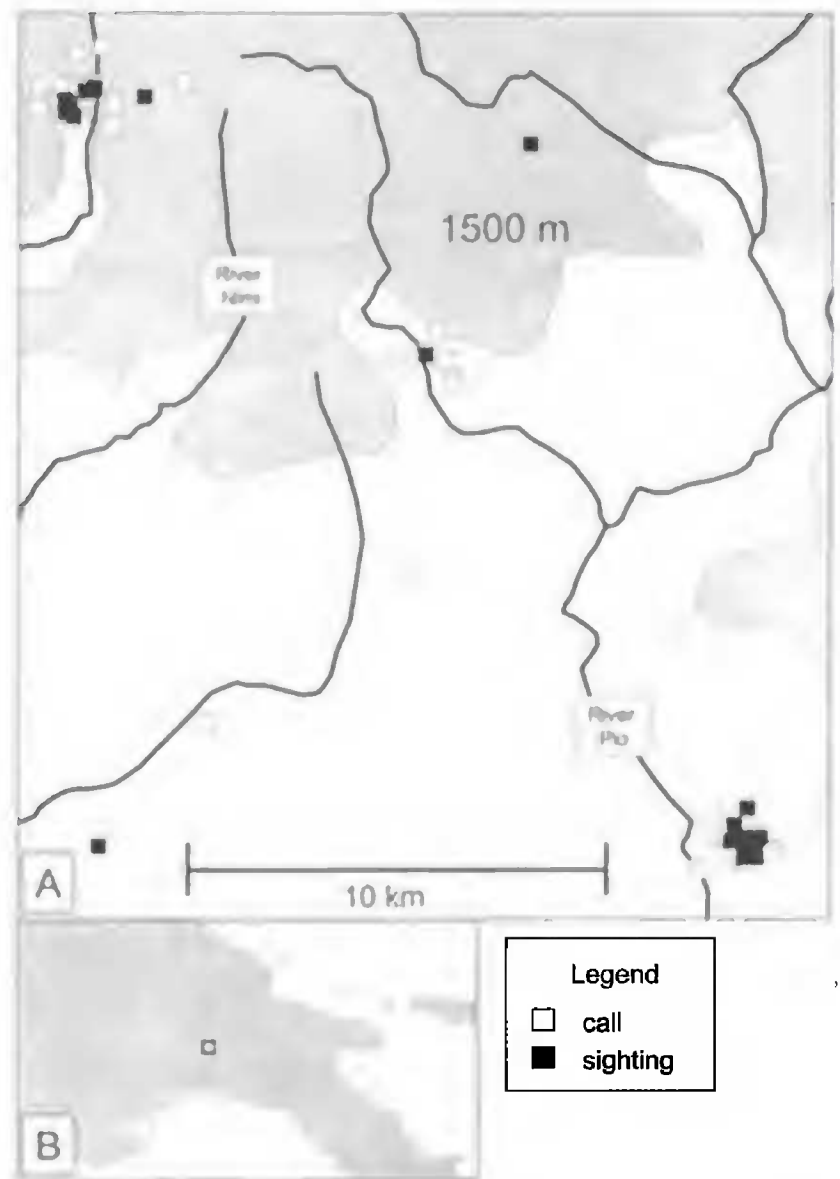


Figure 1. (A) Dispersion of New Guinea Harpy Eagles in Crater Mountain Wildlife Management Area based on sightings and calls. (B) Location of study area in Papua New Guinea.

Prey remains were collected from a recently used nest and beneath perches. Prey identification was based on comparisons with skins and skeletons in the University of Papua New Guinea, Port Moresby, Papua New Guinea.

A 3-yr-old female eagle in the raptor collection of The Rainforest Habitat Centre, Lae, Papua New Guinea was measured and weighed to calculate its wing loading (Kerlinger 1989). This was compared to the wing loading of other species of eagles (Brown 1976).

#### RESULTS AND DISCUSSION

**Dispersion.** We only found New Guinea Harpy Eagles in CMWMA. Over 212 d, we heard eagles calling on 120 occasions and actually observed them on 24 occasions for 1002 min. Based on clustering of points where eagles were seen or heard calling (Fig. 1), we estimated that the area con-

Table 1. Prey species of the New Guinea Harpy Eagle in Crater Mountain Wildlife Management Area ( $N = 10$ ).

COMMON NAME	SCIENTIFIC NAME	NUMBER	HOW IDENTIFIED
Forest wallaby	<i>Dorcopsulus</i> sp.	6	bones in nest, pellet
Ringtail possum	<i>Pseudocheiridae</i>	1	observation
Dwarf Cassowary	<i>Casuarius bennetti</i>	1	bones in and under nest
New Guinea Megapode	<i>Megapodius decollatus</i>	1	bones in and under nest
Fruit-Dove	<i>Ptilinopus</i> sp.	1	bones in nest

tained a minimum of 5 pairs of eagles with an average home range of  $13.0 \pm 3.9 \text{ km}^2$  ( $\pm\text{SD}$ ,  $N = 5$ ). The habitat was not continuous in CMWMA because of areas of cultivation around villages, areas where suitable prey had been hunted out, and areas above approximately 2800 m where scrub replaced forest. Accordingly, we estimated the overall density to be one pair per  $150 \text{ km}^2$  or a total of 10–20 pairs in the CMWMA.

**Habitat Use.** For one pair of eagles, all sightings and vocalizations were within a  $0.25 \text{ km}^2$  area. They were followed for 42 d in May, July, August, and September. During this period, they were not detected for 8 d which coincided with a prolonged period of heavy rain. It was not clear whether the eagles were still in the area and stayed silent or had flown to a different area beyond hearing range. It was remarkable that this pair used such a small area for such a long period. The male eagle used the area to hunt and was seen carrying a ringtail possum (*Pseudocheiridae*) at 1610 H on 2 September 1999.

**Hunting Behavior.** Prey items identified from one pellet and other prey remains were mostly forest wallaby (*Dorcopsulus* sp.) which agreed with descriptions of the diet given by indigenous people (Rand and Gilliard 1967, Majnep and Bulmer 1977; Table 1). Prey were probably taken both on the ground and within the forest canopy. The ringtail possum we observed being carried during the day suggested that, like other nocturnal, arboreal species in this family, possums were taken from their roosting places during the day. We also observed eagles making systematic searches of suitable roosting places for mammals in the crowns of trees. Seven hunters we interviewed described eagles flushing prey from epiphytes or holes by hanging from their legs and beating their wings against the vegetation. Although we did not observe this behavior, it has been described twice in the literature, and is comparable to techniques used by African Harrier Hawks (*Polyboroides typus*) and Crane

Hawks (*Geranospiza caerulescens*) (Majnep and Bulmer 1977, Osborne and Osborne 1992).

Pooling all 40 flights of the six different individual eagles observed, only 4 were  $>100 \text{ m}$ . Similar short hunting flights have been described as “short-stay perched-hunting” in Northern Goshawks (*Accipiter gentilis*) in more open habitats (Kenward (1982). However, one flight made by a female eagle was  $>1.5 \text{ km}$  across a ravine system indicating that New Guinea Harpy Eagles can travel for long distances across the forest. We never observed eagles soaring, which was contrary to descriptions by earlier authors (Rand and Gilliard 1967, Brown and Amadon 1968, Diamond 1972, Peckover and Filewood 1976). The wing loading of the single captive eagle we measured was  $0.91 \text{ g/cm}^2$  which was 1.3 times greater than values recorded for other species of soaring eagles (Brown 1976) suggesting that it is unlikely that New Guinea Harpy Eagles soar. Soaring is unlikely to offer selective advantage in locating prey since the canopy restricts visibility from the air. However, the sympatric but morphologically different Gurney’s Eagle (*Aquila gurneyi*) was seen soaring 80% of the time we observed it during our study. Unlike most raptors that use an aerial display flight in pair bonding and territory defense, the New Guinea Harpy Eagles appear to circumvent this by using an unusual repertoire of calls.

**Vocalizations.** Eagles called mainly during the day (Fig. 2) and this agreed with the pattern of vocalizations described from September–December 1986 on Mt. Missim, Morobe Province, Papua New Guinea (Shulz 1987). This finding suggested that most calling coincides with crepuscular and daytime activities, including hunting. The most frequently-heard call was a continuous, low frequency ( $<500 \text{ Hz}$ ) note that has been described as “like a plucked bowstring” (Fig. 3a, Diamond 1972). Two other calls had a much higher frequency (1400–1600 Hz) and sounded like a variable “chuck chuck” (Fig. 3b, 3c). Both of these calls were heard



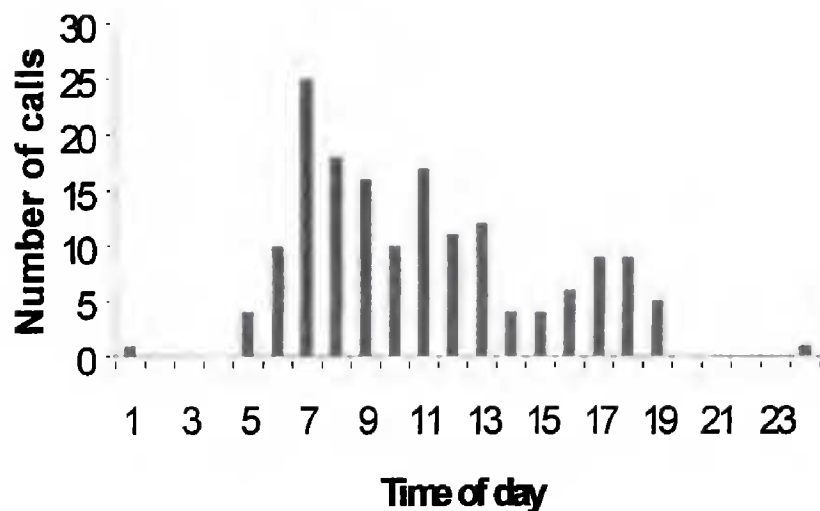


Figure 2. Frequency distribution of New Guinea Harpy Eagle calls by time of day, all individuals combined ( $N = 120$ ).

only from one pair with the first call given by the female and the second given by the male. A fourth call was a combination of the “plucked bowstring” and “chuck chuck” calls (Fig. 3d).

The low frequency call was audible up to 2 km away. Low frequency, continuous calls propagate much more effectively through foliage, so this call may have been used as a territorial advertisement. Strategies of resource partitioning and reproduction differ between temperate and tropical birds. In the tropics, where resources are more stable, territories are often defended year-round and pair bonds are more permanent. As a result, both sexes call year-round to defend food resources and maintain pair bonds (Moreton 1996). The high frequency call was only used by the male eagle when hunting. This call may possibly be used as a stimulus to flush prey from roosting places in the canopy or to lure prey in a manner similar to that used by Northern Shrikes (*Lanius excubitor*, Atkinson 1997).

**Conservation Status.** There was a sharp contrast in the attitudes of villagers toward the New Guinea Harpy Eagle between CMWMA and other areas in Southern and Western Highlands Provinces. In CMWMA, eagles were not hunted and were protected under agreements linked to sustainable development initiatives made with conservation organizations. However, in the other areas, eagles were still hunted for their feathers which are used as symbols of rank and for personal decoration at ceremonies. In one Melpa village, feathers of four eagles shot within the preceding 18 mo were displayed and, in another two Imbongu villages, reliable accounts were given of eagles being killed using slingshots or shotguns. Fourteen hunters who

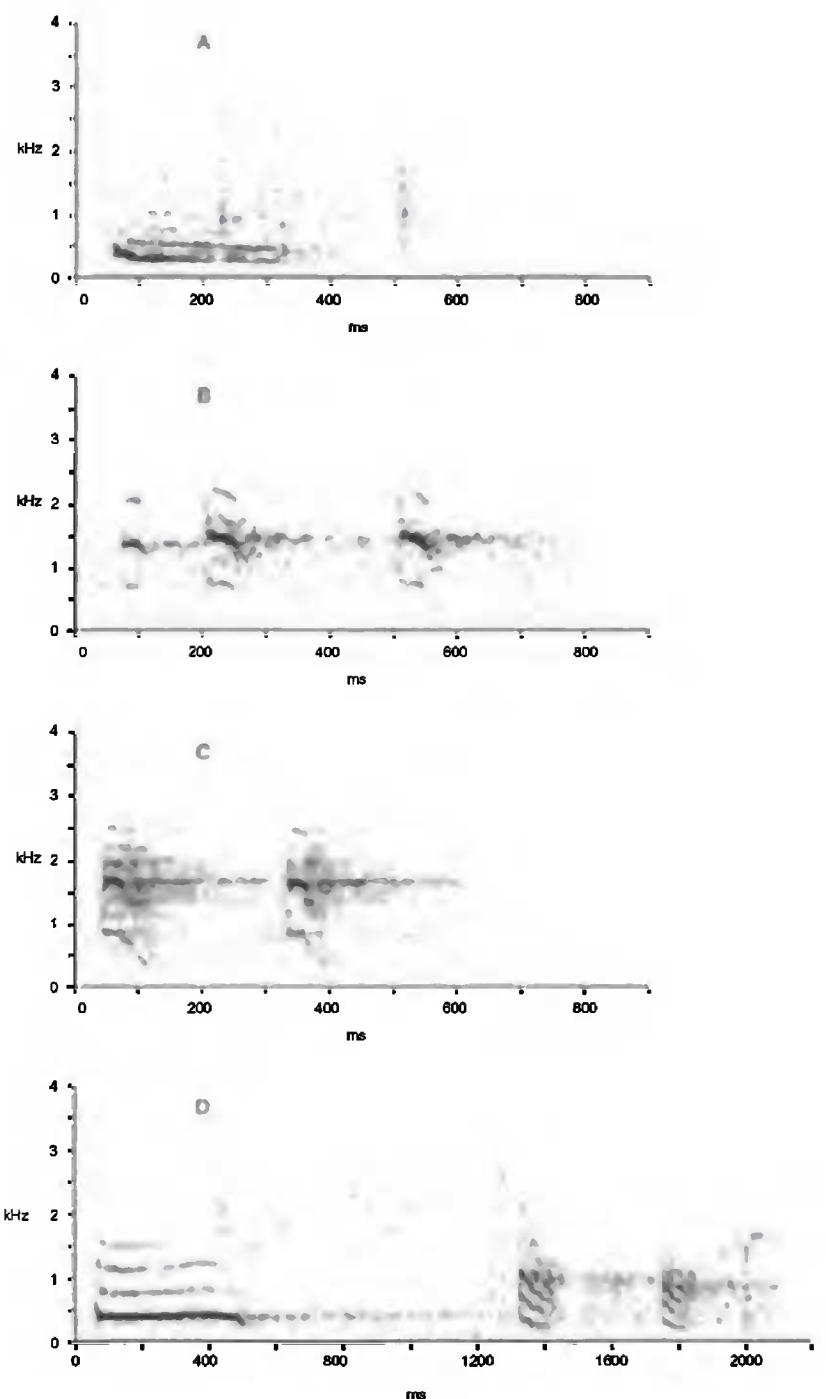


Figure 3. Spectrograms of four New Guinea Harpy Eagle calls from a minimum of 5 individuals: (A)  $N = 63$ ; (B)  $N = 23$ ; (C)  $N = 16$ ; (D)  $N = 13$ .

were interviewed at Mt. Giluwe, the upper Jimi Valley, and the Kubor Range reported that New Guinea Harpy Eagles were rare in their forest. A study of the use of bird plumes among indigenous cultures showed a decline in the frequency of feather trading (Healey 1990). While our results did not allow us to assess directly the effects of hunting on the status of the eagle populations in these areas, we feel that a reduction in hunting pressure and traditional resource extraction through conservation agreements such as those already in place in CMWMA are essential to the conservation of the New Guinea Harpy Eagle.

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